

Exercise for Bone Health and Osteoporosis

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Osteoporosis is a major problem in Western societies, especially if we take into account the complications that this entails: fractures in vertebral bodies, neck of the femur and wrist. Patients presenting these types of complications also experience an increased morbidity and mortality [1,2,3]. More than 10 million individuals in the United States ≥ 50 years of age have osteoporosis and another 34 million are at risk of developing it [2]. In Australia, osteopenia and osteoporosis are estimated to affect ~ 7.5 million people, with a fragility fracture occurring every 3.6 minutes, which equals ~ 400 per day [4]. Twenty two million women in the European Union between the ages of 50 and 84 suffer from osteoporosis and it is estimated that this figure will reach 33.9 million women by the year 2025 [5].

To reduce the risk of fractures in the setting of osteoporosis and osteopenia it is necessary to acquire the best bone mass quality as early as childhood and adolescence. In the case of women a good goal is to acquire this mass before the establishment of menopause. Indirectly, while performing physical conditioning for the improvement of bone quality, we are training other components such as the quality of muscle mass and proprioception, therefore, avoiding the risk of falls [1,2,5].

In terms of prevention with physical activity and exercise, we can talk about three big areas: increase bone mass, decrease bone loss, and reduce risks of falls [1,3].

Let's break down each of these.

Increase Bone Mass

The more an individual takes advantage of his bone gain peak, the more he can risk losing in the future, highlighting the period of adolescence here; nevertheless, genetic factor is a variable [6], it is not the only one. Animal studies have shown improvements in bone mass in response to muscle stimulation and impact exercises such as plyometrics. In studies of school children the incorporation of plyometric exercises in their physical activities translates in improved bone health [1,7]. They were asked to perform 10 jumps each time the school bell rang, for a total of three times a day, and this was found to increase bone density [1].

Although swimming and cycling are not the best exercises for increasing bone mass, a recent meta-analysis comparing aquatic exercises (swimming, hydro-gymnastics) to strength exercise found that it is possible to see improvement in bone mass from aquatic exercises, but not at the same results as those seen with strength training [1,7].

But exercise doesn't act alone. An adequate nutritional contribution is required to build healthy bone mass. It was shown in adolescents that the impact on bones by exercise was better when it was performed in combination with calcium supplementation, 1,200mg of calcium is recommended in this scenario and stage of the life. It has been hypothesized that reaching 10% more peak bone mass at the peak of young adulthood could delay the development of osteoporosis by about 13 years and, ultimately, reduce the risk of fractures by 50% [1,3,4].

Decrease Bone Loss

Once the stage of menopause sets in, it is of critical importance to implement strategies that reduce the rate of bone loss. One such strategy is personalized exercise prescription; However, it should be clear that walking programs are not effective in preventing bone loss and much less in the gain of this. This type of physical activity grants other types of benefits, but by definition it is not the best exercise for the prevention of bone loss and the promotion of bone gain. As early as childhood and adolescence, individuals should be evaluated by a medical specialist in physical activity and sports who does not only prescribe the exercise in an objective manner, but it individualizes it because each individual has different needs, this is not a one size fits all scenario. After the assessment of cardiovascular, metabolic, musculoskeletal, and congenital risks, the medical specialist in physical activity and sports determines the best suitable exercise prescription for that individual with one goal, which is the promotion of bone gain and the prevention of bone loss [1].

In the same way and as mentioned before, the adequate intake of calcium is fundamental, 1,200mg day, as well as the intake of vitamin D 700 - 800IU/day to prevent hip fractures and another fractures without adequate preventive impact on fractures of bodies vertebral [1,8]. Gao *et al* in 2015 conducted a prospective study with 485 postmenopausal Chinese women in order to assess the impact of calcium 600mg/day, calcium (600mg/day) and cholecalciferol (800IU/day) or calcium (600mg/day) and calcitriol (0.25µg/day) and concluded that: "Supplementation with calcitriol and calcium modifies the bone turnover marker levels, and maintains muscle strength and quality of life in postmenopausal Chinese women, whereas supplementation with cholecalciferol and calcium prevents aging-mediated deterioration in quality of life [9]".

Reduce Risks of Falls

Falls are a very important risk factor for fractures and this is aggravated with aging increases. In individuals aged 65 and older, 33.3% suffer at least one fall per year [1,10].

What are the Risks of Falling?

- Visual: Reduced ability to detect low contrast hazards, judge distances and perceive spatial relationships [11].
- Neurological: Seizures, Stroke or TIA, idiopathic Parkinson's disease, multiple sclerosis, pain syndrome, polyneuropathy, spinal disorders, subcortical arteriosclerotic encephalopathy, psychogenic disturbances, motor neuron disease, vertigo, CNS tumors, intracerebral bleeding, meningitis/Encephalitis, non-idiopathic Parkinson's disease, essential tremor, polyradiculitis, dementia, cerebellar disorders, myositis/myopathy, hereditary neurodegenerative diseases, dystonia, subarachnoid hemorrhage, Huntington's chorea, normal pressure hydrocephalus
- Musculoskeletal: sarcopenia [12,13], muscle weakness related diseases or conditions: Loss of motor neurons + decline in anabolic hormones, reduction in number and size of myocytes, decline in locomotor power and strength, inability to perform work [13].
- Disability. Certain medications. such as: benzodiazepines, sedatives, sedating antidepressants, monoamine oxidase inhibitors, antipsychotics, SSRI antidepressants, SNRI antidepressants, opiate analgesics, anti-epileptics, dopamine agonists, muscle relaxants, vestibular sedatives, phenothiazines, vestibular sedatives, antihistamines, sedating antihistamines for allergy, anticholinergics acting on the bladder, alpha receptor blockers, centrally acting alpha 2 receptor agonists, thiazide diuretics, loop diuretics, ACEIs, ARBs, beta blockers, antianginals, calcium channel blockers, antidysrhythmics, acetylcholinesterase inhibitors [14].
- Postural hypotension.
- Bad proprioception.
- Environmental risks, such as: throw rugs, clutter, steps that are too steep or too long, poor lighting, pets, unstable chairs or tables, extension cords across walkways, toilet seat too low, sloping driveway, cracks in sidewalk, wet or slippery surface, obstacles on the ground, dimmed light, barefoot walking or walking with inadequate footwear [15,16].
- Cognitive alterations.
- Gait alterations

It is proven that an adequate physical conditioning prevents the prevalence of all these risk factors. An adequate exercise prescription should include proprioception training and muscle strengthening, as well as certain forms of exercise like Tai Chi [1].

Exercise Test or Ergometry

There is no specific modality for the osteoporosis scenario, this is at the discretion of the sports doctor or doctor of exercise physiology. The American College of Sports Medicine establishes the following special considerations [2]:

- Cycle-ergometry is recommended as an alternative to the treadmill ergometry in the setting of a patient with severe vertebral osteoporosis, especially if they suffer from a painful ambulation.
- Vertebral fractures can lead to a deformity of the spine with displacement of the center of gravity; this affects the stability on the treadmill belt so, another alternative can be given.
- Maximum strength tests may be contraindicated in severe osteoporosis; however, there are no guidelines in this regard that evidences the aforementioned contraindication.

A good alternative in these scenarios is to obtain the 1-RM by methodology of Brizcky or Landers (methodology widely used in the physical activity and sports Medicine program at the FUCS-HIUSJ (Fundacion Universitaria De Ciencias De La Salud - Hospital Infantil Universitario De San Jose).

The ESSA (Exercise and Sports Science Australia) in its position statement offers another alternative to what is described below using the Borg scale and the fracture risk mediated by fragility [4].

Prescription of the Exercise

FITT Principle = Frequency, intensity, time and type.

Patients at risk of osteoporosis

Frequency: aerobic exercises with weight 3-5 times / week; Strength exercise (bodybuilding) 2-3 times/ week.

Intensity: Aerobic: moderate - vigorous ($\geq 60\%$ VO₂ or reserve FCM), in terms of moderate strength 60-80% 1-RM, 8-12 repetitions or vigorous 80-90% 1-RM 5-6 repetitions always involve larger muscle groups.

Time: The recommended duration is between 30-60 minutes between the aerobic and strength components.

Type: The recommended training modes are for aerobics, going up and down stairs, interval walks with jogging, exercises that involve jumps like volleyball, basketball, plyometrics. Strength exercises like free weights, machines, suspension exercise (TRX®), self-loads, functional among others.

They will always be special considerations, so once given general recommendations in terms of purely physical activity, it is recommended to refer the patient to a sports doctor, being the ideal to generate an objective and individualized prescription for the best benefit of the patient.

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